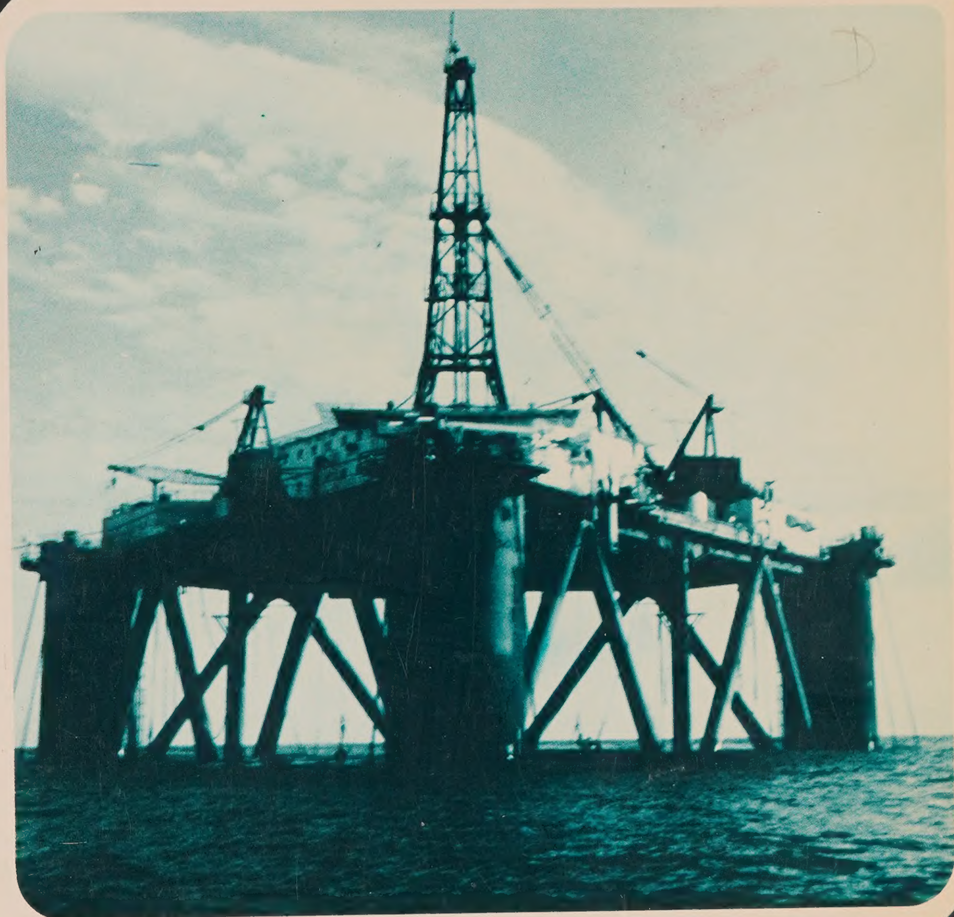
RESOURCES UNDER THE SEA



Energy, Mines and Resources Canada
Énergie, Mines et Ressources Canada

Prepared for Resource Management and Conservation Branch
by Information EMR

(aussi disponible en français)

COVER PHOTO:
A semi-submersible drilling unit
off Canada's East Coast.

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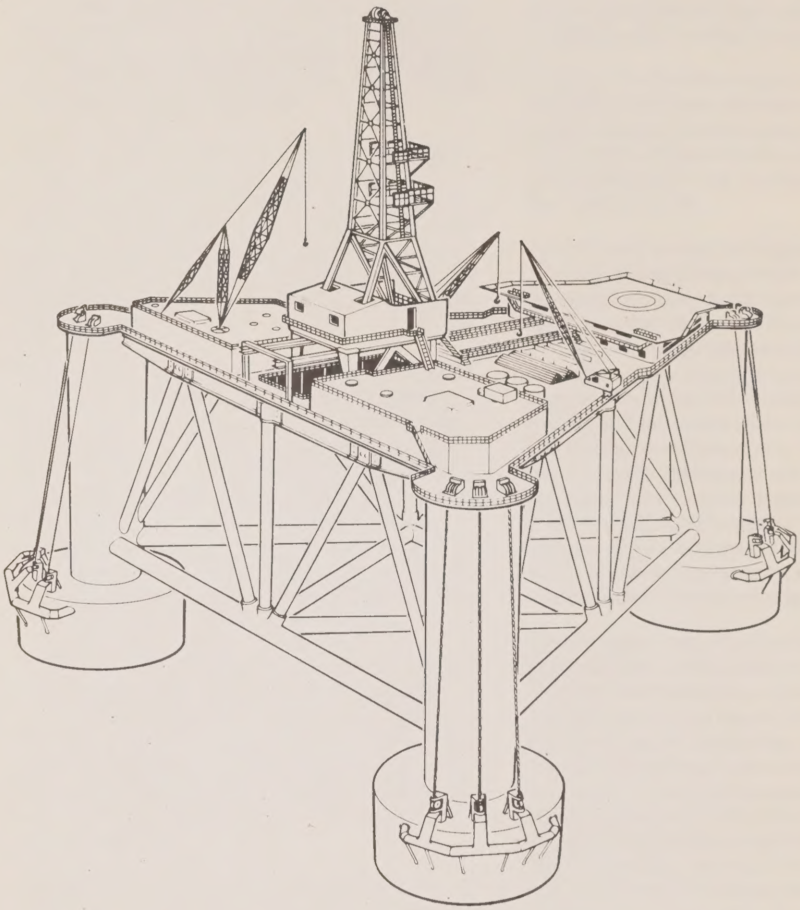

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Resources under the sea

"IT'S OIL!" was the massive headline in a Halifax newspaper in the fall of 1971 after an oil company announced it had discovered oil, natural gas and condensate (liquids associated with natural gas) in a well that was being drilled on lonely Sable Island, 180 miles southeast of Halifax.

This was the first "big" find in the drilling program going on in the seas off Canada's coasts, commonly called "the Offshore". What has stimulated this drilling in the Offshore, especially in the stormy Atlantic Ocean off the East Coast? Why are oil companies drilling in the Offshore when it costs ten times as much money to drill a well at sea as it does on land?

First, there is the matter of supply and demand. At the moment, oil and natural gas provide almost three-quarters of Canada's energy requirements and the demand increases daily. Every new car that comes on the market requires gasoline and lubricating oil to operate. Each day across Canada many new homes are built; most will use oil or natural gas for heating. This consumption is growing so fast that Canada's requirements for oil and natural gas in the year 2000 may well be three or four times the amounts used in 1970.

Secondly, if Canada is to minimize the amount of petroleum imports, then the additional requirements for future years must come from domestic supplies. Reserves and new finds of oil and gas in the provinces are dwindling so the oil companies, in their continuing search for petroleum, have had to resort to the frontier areas of Canada—in the Offshore and in the Arctic.

Canada's submerged continental margin, that part of the continent that extends beneath the sea offshore from Canada, is the second largest in the world, exceeded only by that of the USSR. Canada's continental margin is estimated to cover almost two million square miles, an area about half as large as the total land area of Canada. Of this, about one third lies off the East Coast, about 400 thousand square miles in Hudson Bay and Hudson Strait, some 50 thousand square miles off the West Coast, and the remainder is in the Beaufort Sea and the region of the Arctic Archipelago.

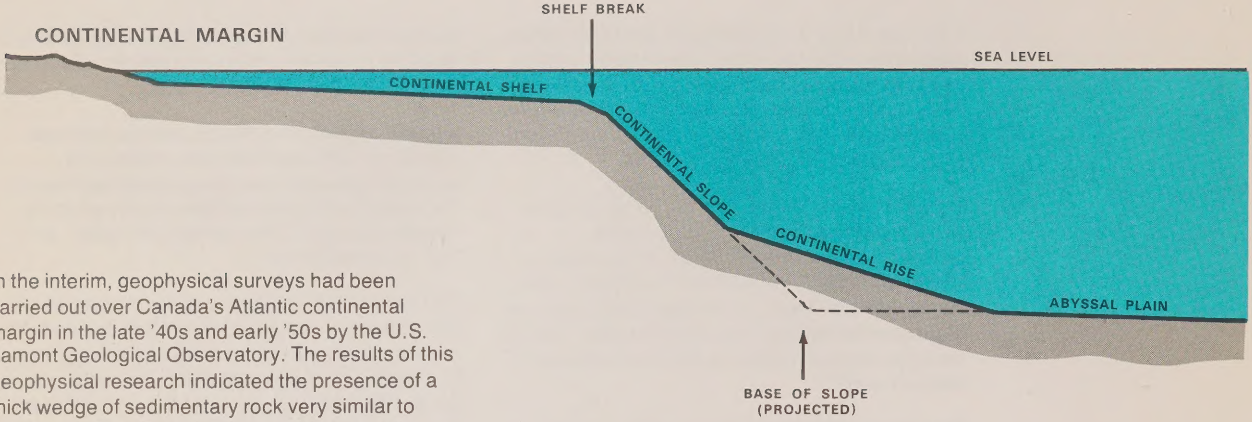
By now you might be wondering how far out to sea does the continental margin go and actually what is meant by the "continental margin"?

Canada's continental margin extends from less than 50 to more than 400 miles offshore. An accepted geological and geophysical definition of the margin comprises the features known as the "continental shelf", the "continental slope", and the "continental rise".

The continental shelf is that gently dipping part of the seabed extending out from the shoreline to the significant increase in dip marking the beginning of the continental slope. The shelf dips oceanward at an angle of considerably less than 1°. Off Canada the outer edge of the shelf occurs at water depths ranging from about 120 metres to about 650 metres, and averaging about 400 metres, whereas the reported world average is 132 metres. The slope dips at an average angle of about 3°, extending down to water depths ranging from 2,000 to about 4,000 metres in the case of Canada. From the slope the seabed dips more gently on the continental rise, ultimately merging into the abyssal plain (see diagram).

What triggered industry's decision to look for hydrocarbons in the Canadian Offshore? By the 1950s, as the result of successful exploration that had been carried out mainly off the Gulf Coast of the United States, it had been accepted that the continental shelf was a favourable area to look for oil and gas. A first look was taken at Canada's offshore geology in 1945, when an oil company drilled a well in Hillsborough Bay off Prince Edward Island. The same company 26 years later became the first to make a significant discovery on our Atlantic continental shelf—at the western tip of Sable Island, in 1971.

CONTINENTAL MARGIN



In the interim, geophysical surveys had been carried out over Canada's Atlantic continental margin in the late '40s and early '50s by the U.S. Lamont Geological Observatory. The results of this geophysical research indicated the presence of a thick wedge of sedimentary rock very similar to that found along the Atlantic coastal plain of the eastern United States and Gulf Coast. By analogy with the Gulf Coast region, a high potential for hydrocarbons was indicated in this sedimentary basin.

In 1959, an oil company carried out geophysical surveys near Sable Island, following this up a year later by taking out the first oil and gas exploration permits off Canada's East Coast. Industry activity in this region has since increased markedly, so that by mid-1972 the greater part of the continental shelf and slope extending from Georges Bank in the south to Baffin Bay in the north was covered by Canada oil and gas permits.

The Department of Energy, Mines and Resources (EMR) had, by the mid-1960s, carried out geological and geophysical reconnaissance investigations over areas of the Atlantic continental margin. By 1969, spurred by industry's activities in the Offshore, a more intensive study of specific areas such as the Scotian Shelf, the Grand Banks and the Labrador Shelf, was under way. This program includes mapping the surficial geology of the seabed by sampling and thorough examination of shallow geophysical records. Results of this work are made available to the public, and exploration companies make valuable use of it in the continuing search for offshore oil and gas.

In the Hudson Bay region the work of the Geological Survey of Canada was instrumental in discovering a relatively deep sedimentary basin.

This initial survey has been followed up by industry with more detailed seismic work. The results have been promising and one well has already been drilled, with more drilling planned for 1974.

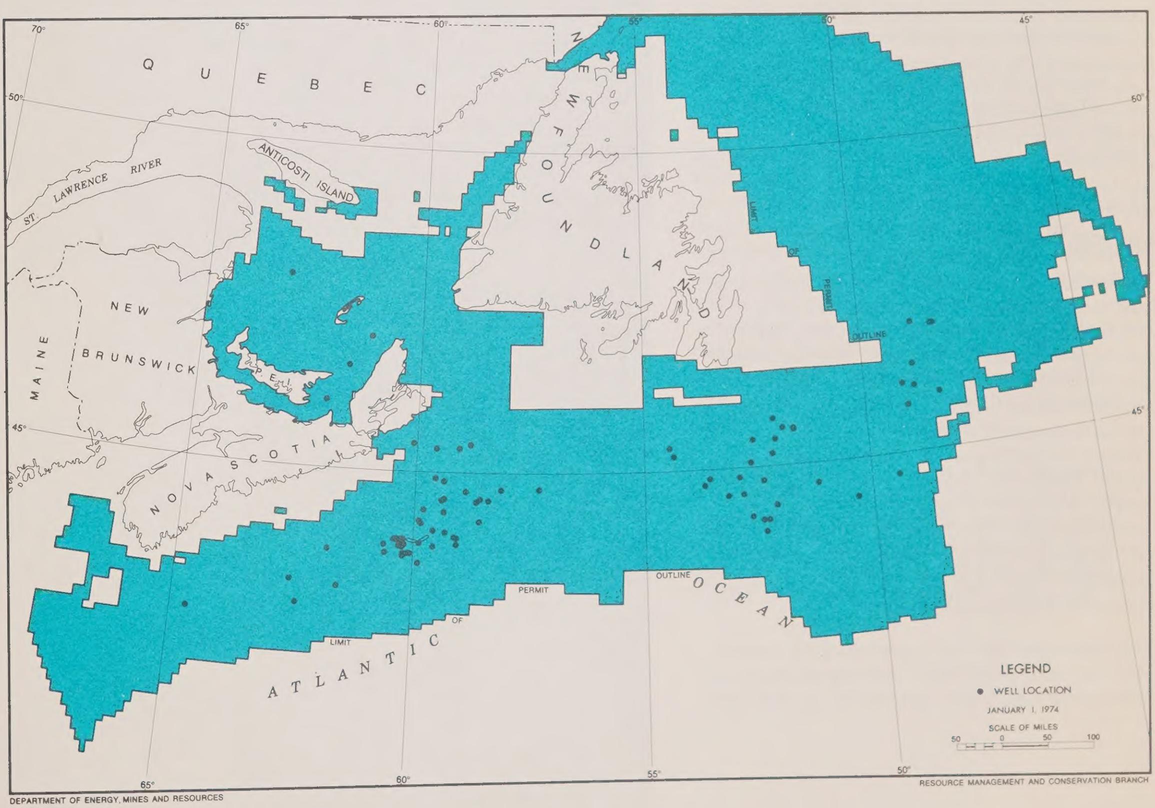
Gradually information is being obtained on the continental margin on the type of rocks underlying the seabed, all of which is of interest to government and industry. The first firm indication of what underlies the Grand Banks came from the results of a 1965 "corehole" drilling program carried out by an oil company. A drill-ship was used to put down relatively shallow holes from which the rock was recovered and studied by geologists. One of these holes was in 3,500 feet of water, a world's record at that time. Several coreholes were drilled to a depth of 1,500 feet below the seabed. This was followed in 1966 with the first deep drilling program designed specifically to explore for oil and gas on Canada's Atlantic Shelf, on the Grand Banks, with one well drilled 100 miles offshore and a second 175 miles offshore.

The following year the first drilling took place on the Scotian Shelf, when Mobil Oil drilled a deep well on Sable Island.

Areas under Canada oil and gas permits in the Atlantic Ocean and Gulf of St. Lawrence, showing locations of wells drilled.

The current phase of continuous and still accelerating drilling activity in the East Coast Offshore began in the fall of 1969, when Shell Canada commenced an extensive drilling program on the Scotian Shelf. Other important drilling programs have been undertaken by Mobil Oil Canada Ltd. on the Scotian Shelf, Amoco Canada Petroleum with partners Imperial Oil, Chevron and Skelly on the Grand Banks, and Hudson's Bay Oil and Gas and Shell in the Gulf of St. Lawrence. Altogether, 82 wells have been drilled to date (January 1974) in the East Coast Offshore, including 46 on the Scotian Shelf, 29 on the Grand Banks, four in the Gulf of St. Lawrence and three on the Labrador Shelf.

It is of interest that the first drilling off the West Coast of Canada was carried out by a huge semi-submersible drilling unit built at Victoria, B.C., at a cost of $12 million. This unit, the SEDCO 135 F, carried out a 14-well drilling program off the West Coast for Shell from mid-1967 to mid-1969. It then proceeded to New Zealand and, after a 13-thousand-mile, 6-month tow from New Zealand, is now drilling in the North Sea.



Resource Management and Conservation Branch

Many people thinking about offshore drilling immediately envisage oil gushing up from under the sea, drifting to land and polluting the beaches. The federal government has adopted stringent measures for the Canadian Offshore to ensure that this does not happen. Legislation has been enacted by Parliament to provide effective control over any company wishing to operate in the waters off the coast. The Resource Management and Conservation Branch (RMC Branch) of the Department of Energy, Mines and Resources is charged with the responsibility for enforcing this legislation.

The Branch administers and manages the federal interests in mineral resources off the East and West Coasts and in the Hudson Bay and Hudson Strait regions, as well as those federally-owned mineral rights in the provinces that become available for development. The Branch designs, issues and administers the various types of offshore permits and leases, and establishes the requirements for operational, production, conservation and pollution-control measures. Branch officers then exercise supervision and control over offshore mineral resource activities to ensure compliance with these requirements. For example, an engineer from the Branch is actually at the drill-site during the critical stages of a drilling operation for oil and gas.

The Branch also provides recommendations and advice on national offshore mineral resource policies and programs. Personnel of the Branch also supply representation and expertise in interdepartmental, federal-provincial and international offshore matters, including participation in various United Nations committees on Law of the Sea matters, including seabed mineral resource activities. The Branch provides the coordination and liaison among the numerous industry and governmental agencies concerned with utilization of offshore areas, and provides advice to other governments and agencies on offshore mineral resources and related matters.

The main legislation administered by the Branch falls into two general fields: land management and operational supervision and control. In the former, the issuance of offshore oil and gas licences, permits and leases is covered by the *Canada Oil and Gas Land Regulations* under the statutory authority of the *Public Lands Grants Act*. Operational matters fall under the *Oil and Gas Production and Conservation Act* of 1970, which provides comprehensive statutory authority for controlling all oil and gas operations in the Offshore, including the prevention of pollution, the conservation of resources, and the safety of personnel. For example, the Branch has the authority to stop a drilling operation in any area under its jurisdictional control, if the operator is not complying with government requirements.

Canada is one of the few nations in the world in which industry is required by regulation to submit to the government complete suites of rock samples and cores, fossil specimens and mechanical well-logs obtained in the course of drilling for oil and gas. To handle this material a Regional Office-Laboratory was established by the Branch in 1970 at Dartmouth, Nova Scotia, where the materials from wells drilled off Canada's East Coast and in the Hudson Bay and Hudson Strait regions are received. EMR's Institute of Sedimentary and Petroleum Geology in Calgary, Alberta, at present stores materials from wells drilled off the Pacific Coast on behalf of RMC Branch.

The information and materials supplied by industry from offshore wells are held confidential for two years, after which they are made available for public examination. These materials are helping to provide a comprehensive geological history of the continental margin that will assist future oil and gas exploration in the area.

Microfossils are picked and mounted on slides at the RMC Branch laboratory.

Control of exploration

Earlier the terms "licences", "permits" and "leases" were mentioned. What do these mean, who issues them and how?

A company, whether looking for oil, gas or other minerals, cannot carry out work of any kind over Canada's continental margin without receiving authorization to do so from the RMC Branch.

A company, if it wants to look for oil and gas, must first obtain an exploration licence; it is non-exclusive and is renewable on an annual basis. A licence is necessary whether or not the party is already a permittee or lessee. It is in effect a "hunting licence", since with it a party may apply to carry out exploration work in any region of the Offshore not restricted in some fashion, short of drilling a well, including areas held under permit by other parties. The concept here is to encourage work throughout the Canadian Offshore and at the same time maintain control over all activities through operational and reporting requirements.

The second element in the Canadian resource management system is the exploration permit. This involves a specific area and confers certain exclusive rights. Authorization to drill a well within a permit area can be obtained only by the permittee, and only the permittee has the option of selecting leases from a permit area for the exploitation of oil and gas. The permit is normally a grid or half-grid area delimited by lines of latitude and longitude that vary in size depending on location because of the northward convergence of meridians of longitude. For example, off the northern tip of Labrador a permit area would be less than 64,000 acres while south of Nova Scotia it would be more than 95,000 acres.

Permits are valid for six years with six renewals, each of one year's duration. The company must make guaranty deposits at the beginning of each designated work period to the full amount of the work requirements to ensure that the stipulated amount of exploratory work will be carried out.

These deposits are refunded once the work has actually been performed and the expenditures involved have been approved by the Branch. Work requirements increase progressively from relatively inexpensive reconnaissance geological work, through detailed geophysical surveys, to a high-cost exploratory drilling operation. The latter can cost more than $2 million!

It should be emphasized that, even though a company has received an exploration permit, each offshore program within the permit area, including geophysical surveys or the drilling of a well, must be approved on an individual basis by the RMC Branch before operations can actually begin.

Once a company has established a commercial gas or oil find in a permit area, an application must be made for an exploitation lease. Emphasis is placed at this stage on direct revenues, primarily through royalties on production and annual rentals. A company may acquire leases covering up to half the area of a permit, with the portion not converted to lease reverting to the Crown. This portion can then be re-issued in various ways; for example, it can be put up for public tender and re-issued on either a cash-bonus or work-bonus basis, in permit form or lease form.

The federal government ensures that there is opportunity for Canadian participation at the lease stage. To qualify for a lease, for example, an individual must be a Canadian citizen, and a company must be incorporated in Canada.

As mentioned earlier all proposed work programs for the Offshore must be submitted for prior authorization by the RMC Branch. The Branch's system of control involves a number of safeguards. Before undertaking an offshore exploration program, a party must first submit for Branch approval an *Offshore Program Notice* describing the proposed work in detail, for example, each seismic survey. Drilling an offshore well involves special requirements. A well cannot be started until Branch authorities have approved an *Offshore Drilling Notice* setting out in detail the company's proposed drilling plans.

In practice there are a large number of matters that will already have been discussed in detail between Branch and company officers before a company gets to the stage of actually submitting an *Offshore Drilling Notice.* Following authorization to drill, the well operations themselves are then subject to supervision by Branch officers, who inspect each drilling location to ensure that the federal government's requirements are being met. When a well has reached total depth, approval must be obtained from the Branch for the manner in which it is to be completed, suspended or abandoned.

The Department of Energy, Mines and Resources is not the only government department interested in the Offshore. The Department of Indian Affairs and Northern Development is concerned with offshore mineral resources in the high Arctic; the Department of Fisheries and the Environment, the conservation of living resources; the Department of National Defence, defence installations and naval operations; the Ministry of Transport, the many aspects of navigation and shipping. These departments are notified far enough ahead to allow time for appropriate action.

Protection of the environment

One of the main concerns of the Resource Management and Conservation Branch is the protection of the marine environment. The RMC Branch must consider two primary factors: the exploration and development procedures and equipment, and the seaworthiness of the vessels and installations.

When a company submits a proposed offshore program for approval, it must provide detailed information about a number of matters. In the case of a well, these details would include, for example, the proposed design and implementation of casing and cementing procedures. What is meant by "casing and cementing"? One of the first steps in a drilling operation, after the rig has been firmly anchored over the location, is to drill a large hole more than two feet in diameter to a depth of several hundred feet. Lengths of protective steel pipe are connected together and lowered into the hole to form the "casing". Cement is then forced down the inside of the casing and back up on the outside, cementing it firmly in place. This casing not only prevents surface water and unconsolidated rocks from filling the hole, it provides one of the elements in controlling excess pressure, which might be encountered as the hole penetrates new formations. As the well goes deeper, additional casing strings are required to ensure that there is always sufficient protective steel pipe to contain any high pressure zones that might be found.

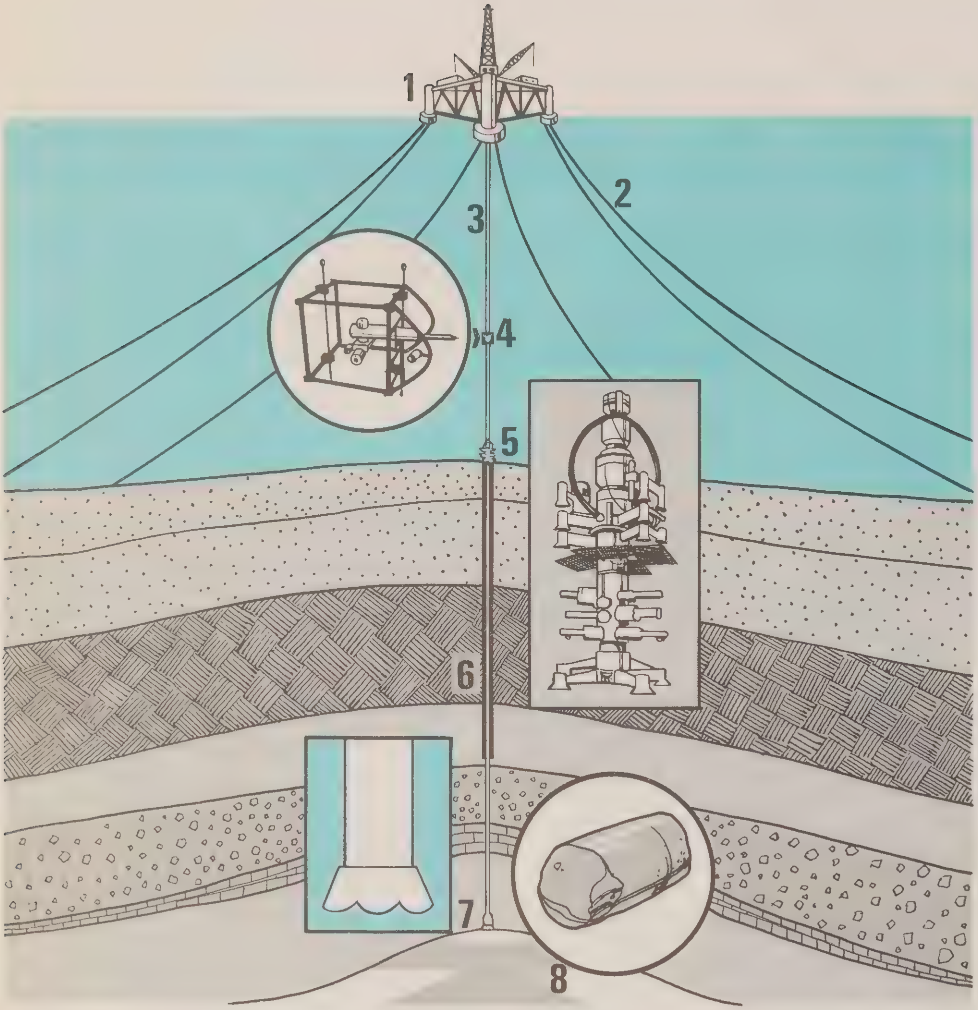
For offshore drilling a special "blowout preventer" has been designed which sits on the seabed, over the top of the hole. This device consists of a number of large valves and other shut-off mechanisms through which the drill-pipe can pass, but which are so designed that they can seal off the well even when the drill-pipe is in the hole. In the event of a potential blowout, this preventer can be closed within seconds to effectively shut off the flow of gas or oil before it can escape uncontrolled into the sea.

Another important procedure in the prevention of blowouts is the careful monitoring of "drilling mud" returns, which usually give the first indication of abnormal pressures in a well. At the first sign of excessive pressures, the weight of the drilling mud is increased to act as a counterbalance. The drilling mud is not ordinary mud but a scientifically compounded mixture of water, clay and chemicals that is pumped continuously down the rotating drillpipe, through the holes in the bit, and then back to surface in the space between the pipe and the wall of the hole. A great deal of effort is expended in making sure that all the flow properties and other characteristics of this "mud" are properly maintained.

The seaworthiness of the drilling-vessel is under continuous scrutiny by the RMC Branch. The manner in which a well is to be drilled is related to the suitability of the equipment and its capability to cope with the sea and weather conditions that may be encountered in the area. Stability of the unit, buoyancy in severe storms or collisions and the strength and reliability of the moorings, all have a fundamental bearing on the effective and uninterrupted control of the well and on the safety of personnel on board.

Strict safety measures for personnel are required by the government, and these requirements are carefully adhered to by industry. Everyone working on an offshore drilling unit must know exactly what he has to do in the event of an emergency. This knowledge is acquired through frequent drills. In this way, lives will be saved if a sudden crisis occurs. In addition, as soon as anyone arrives on the drilling unit he is immediately given a card containing emergency instructions; he also receives a briefing on what to do and where to go in the event of a fire or an emergency that might require the ship to be abandoned. When drilling operations are in progress, a support vessel stands by off the rig in case of possible emergency.

Chance of an oil spill occurring during the drilling of an offshore well is remote, but plans are always made to take care of the unexpected. A company,



when applying for permission to drill a well, must include with the application a detailed contingency plan on how it would combat an oil spill, should it occur. This plan emphasizes prevention and the immediate clean-up operation that the company would undertake if an oil spill should occur. If such an accident did happen, the RMC Branch would literally be looking over the shoulder of the company to ensure that it was taking prompt and effective action to shut off the source of the spill.

The Branch would, as the ultimate enforcement, take over control of the rig at the operator's expense and initiate action to remedy the situation.

The company's contingency plan, once it has been approved by the RMC Branch is coordinated with the National Contingency Plan, which is directed by the Ministry of Transport in cooperation with the Departments of Fisheries and the Environment and National Defence. In the case of an oil spill, Ministry of Transport officials would take charge of the clean-up operation.

DIAGRAMMATIC SKETCH OF OIL DRILLING OPERATION

1. Drilling Rig
The semi-submersible drilling unit is 380-feet wide and 350-feet long and the height from the bottom of the vessel to the top of the derrick is 325 feet.

2. Anchors
Nine mooring chains extend a half a mile from the unit in all directions. At the end of each is a 30,000 lb anchor.

3. Drilling pipe and riser
The drill pipe, a string of 30-foot pipe lengths with the drilling bit attached at the bottom, runs through the riser. The riser, a large diameter pipe which extends from the rig to the blowout preventer, guides the drill pipe into the hole and isolates the drilling system from the sea.

4. Underwater eyes
A television camera is lowered to the ocean floor to check equipment.

5. Blowout preventer
The preventer weighing 65 tons and 35 feet high is a device with which the driller can seal off the well when unexpected conditions are encountered. It is firmly attached to the wellhead on the ocean floor when drilling starts and is operated by hydraulic lines running to the surface.

6. Underground casing
As the bit drills deeper, the hole is periodically lined with steel and cement. This prevents caving and seals off high pressures.

7. Drilling bit
In hard rock a bit may drill only a few feet before it becomes dull. In soft shale, it may cut through 100 feet an hour, and last a day or more.

8. Core sample
Core samples are cut from sedimentary rocks from which oil and natural gas are produced with a special diamond bit. Underground "pools" of oil exist only in the imagination.

The federal government has developed what are undoubtedly among the world's most stringent precautions to prevent oil pollution of our offshore waters and coastal beaches from offshore oil and gas activities. The oil industry is cooperating fully by careful observance of the regulations, and by ensuring that it is fully aware of the hazards involved. The system of strict control exercised by the RMC Branch permits exploration for and production of oil and gas and, at the same time, protects the living resources of the sea and preserves the shoreline environment for its economic, recreational and aesthetic values.

From a simple statistical standpoint, not taking into account the stringent Canadian offshore requirements, there is only a small chance of a serious spill resulting from offshore oil and gas exploration or production. There have been more than 25,000 offshore wells drilled to date, more than 15,000 of which have been drilled in the U.S. Gulf Coast alone.

In studying the sources of marine pollution, it has been found that 70% originates on land, in most cases brought down by rivers, and that virtually all of the remainder comes from shipping, in particular, discharges from, and accidents to, oil tankers. Spillage from offshore oil facilities and operations contributes less than .002% to marine pollution. Indeed, successful offshore oil and gas development will reduce the need for transporting oil to our coasts by huge tankers, and thus could actually result in a net reduction in pollution of our coastal waters and beaches.

Washed cuttings are processed at the RMC Branch laboratory.

Industry in the offshore

Let us now take the case of a fictitious oil company—we shall call it the Canoil Company—and follow the procedures that a company must go through to drill a well on the continental margin somewhere off the East Coast. The company geologists would first study all available materials and select a likely area for the discovery of oil or gas. They could, for instance, examine well logs, well history reports, cores, cuttings and microfossils at the RMC Branch regional office in Dartmouth, and check reports of offshore geophysical and geological surveys carried out by federal scientists of the Atlantic Geoscience Centre.

Once Canoil geologists decide on a likely area and, if the company management agrees with their findings, the company would make an application for an exploration licence. The company would then submit an *Offshore Program Notice* to the Branch for approval at least 45 days in advance of the proposed commencement date of its proposed program of offshore work. Once authorized by the Branch, the company would proceed with the program. Normally, reconnaissance marine seismic surveys would be conducted at this stage.

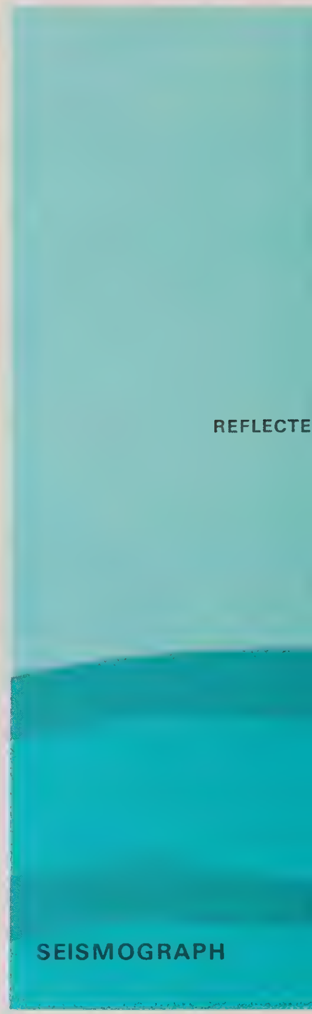
Marine seismic surveys are carried out to determine what the earth is like under the seabed. These surveys are similar to those carried out on land where, to provide the energy source, explosives are generally used to create the reflected echoes from the rock strata or levels.

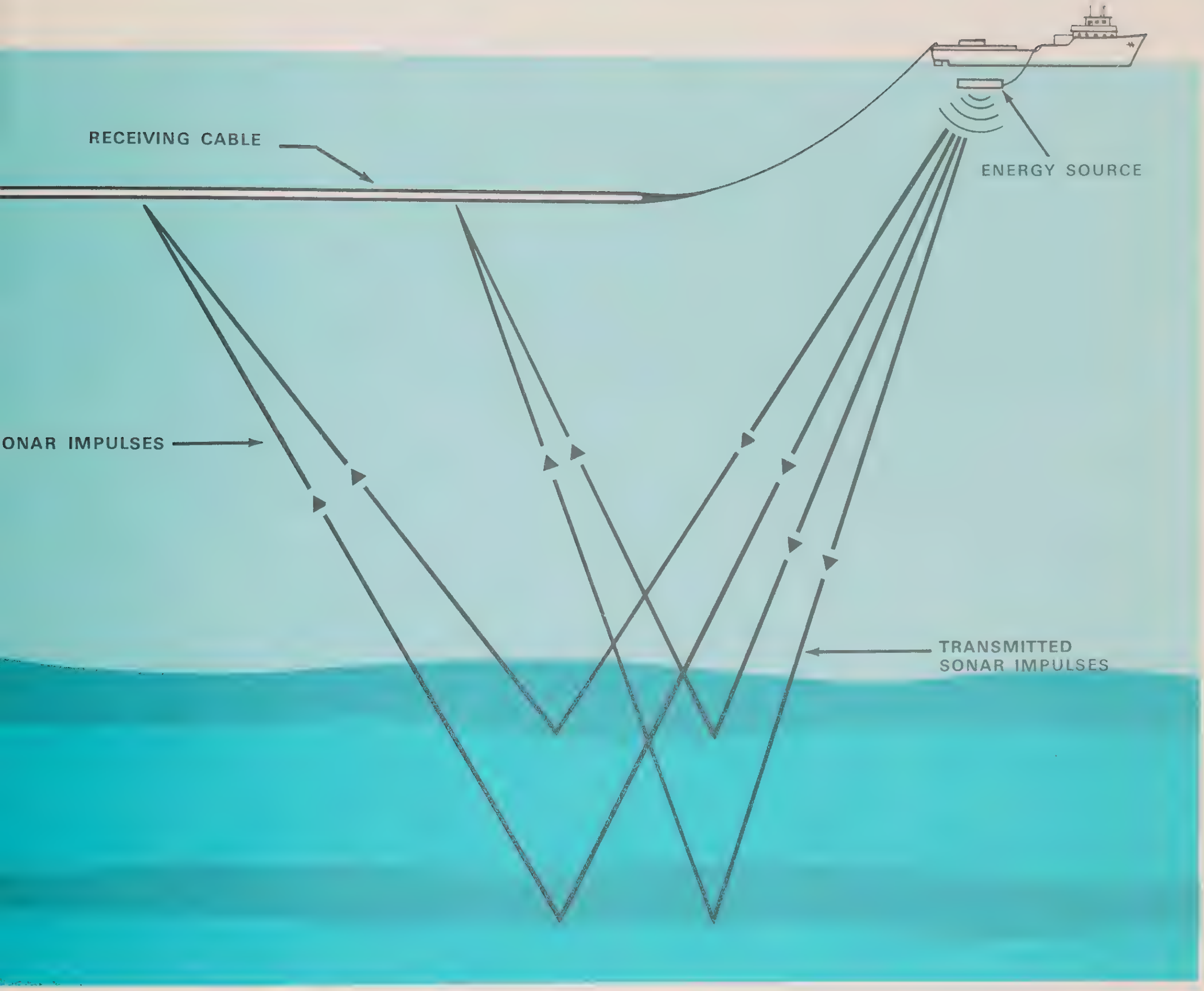
At sea explosives were used at one time but these were expensive and sometimes harmful to marine life. Research was carried out to find suitable devices that would send energy impulses into the ground but not kill any fish. In one procedure that has been developed, a boat tows an automatic repeating sound source that "pings" every 10 seconds to send sonic pulses through the water into the earth's crust. Another method is to use air-guns with a specially designed pulse shaper. Pulses reflected from the underlying formations are picked up by detectors spaced along a towed receiving cable. These reflections, suitably processed and displayed as functions of time or depth, provide approximate portrayals of cross-sectional slices of the earth, on a compressed scale.

If the results of preliminary work confirm the expectations of the geologists, then Canoil Company would apply for exploration permits covering the areas involved. A formal application would be made to the RMC Branch stating the grid areas requested. If the applicant meets the regulatory requirements and the areas are available, the permits would be issued. The company must pay a fee for each permit and make guaranty deposits to the full amount of work requirements for the first three years. These guaranty deposits, which must be made at specified intervals during the life of the permit, will be returned to the company as it carries out the required amounts of work.

After Canoil Company has received an exploration permit or permits, the next step would likely be to carry out further seismic surveys, in order to delineate prospective structures and to choose suitable drilling locations to test these structures. Each time Canoil wishes to do another seismic survey, it must submit in advance of the program an *Offshore Program Notice* describing the proposed program in detail, e.g., location, equipment, duration, contractor, etc. Within a year after completing the survey, Canoil must forward a report of the results, including interpretation and maps, to the RMC Branch.

The next step, once the company geologists have all the information they need, would be to decide on the most favourable location to drill a well, if indeed the results of the seismic surveys had indicated that drilling is justified. The geologists





To obtain a "picture" of the subsurface geophysicists rely on the reflection seismograph.

select what they consider is a likely position where oil or gas might be found, but this can be verified only by drilling a well. When plans have reached this stage, an *Offshore Drilling Notice* would be submitted to RMC Branch for authorization to drill the well. Of course, company officials would have already consulted extensively with RMC Branch officers before actually submitting the application.

Various other federal departments would also have to be notified that drilling is to take place. For instance, the Ministry of Transport would have to issue a Notice to Mariners to warn ship captains of the future presence of the drilling vessel, which might be close to a busy area such as a shipping lane or a favourite fishing ground.

A major consideration for both the company and the RMC Branch, and one that would actually have been planned long in advance, is the contracting or leasing of a suitable offshore drilling unit that can be operated safely and efficiently in the area where the drilling is to take place. One of the very first items the Branch assesses in analyzing a proposed drilling program is the 'stability' of the drilling unit which the operator intends to use. There are a number of types of offshore drilling units such as semi-submersibles, floaters, and jack-ups, and within these basic types there are wide variations. The suitability of a particular unit to work in a specific offshore area has to be carefully assessed.

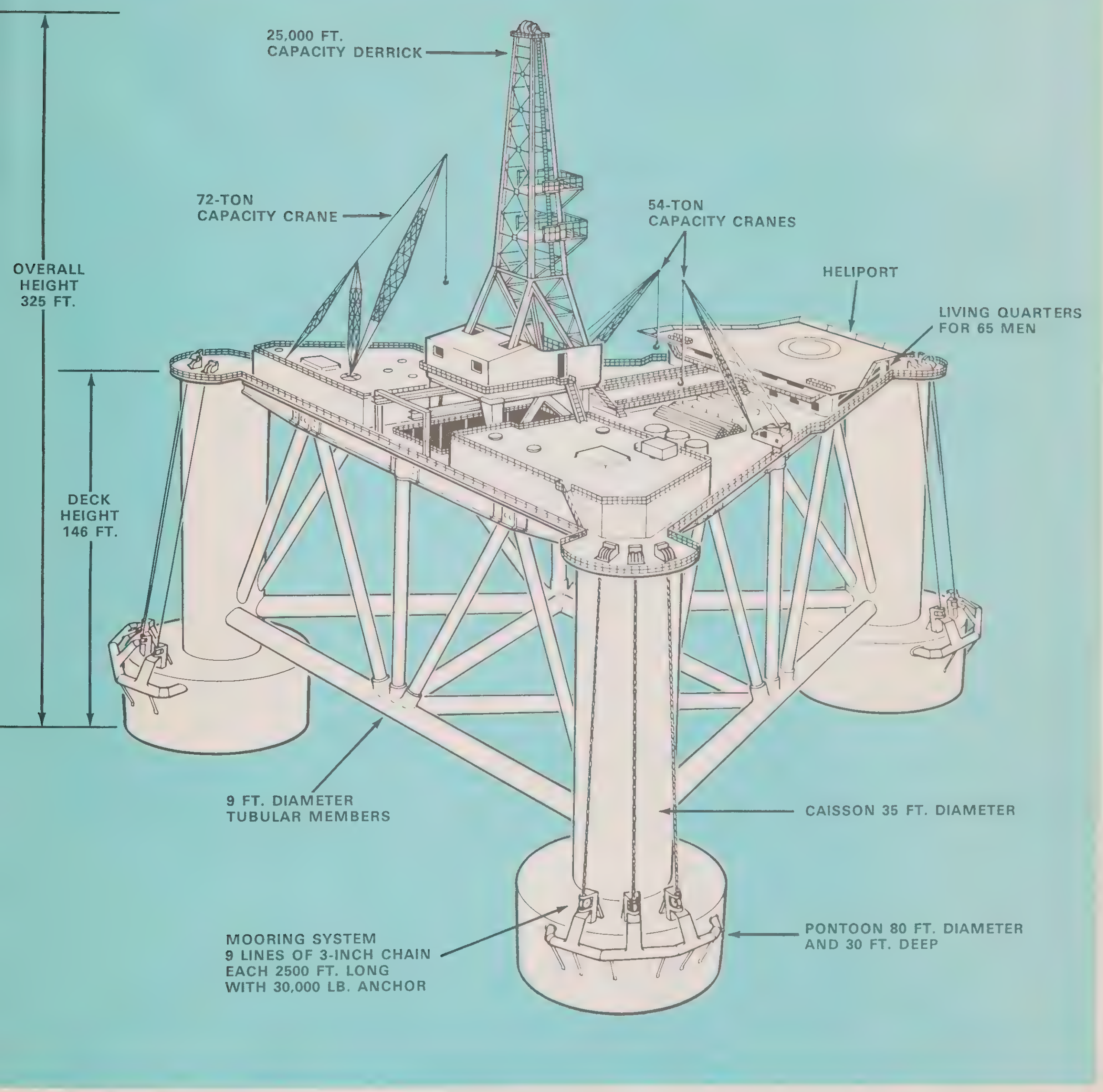
The real "Cadillacs" of the offshore industry are the large semi-submersible drilling units. By the fall of 1972 three of these large units had been built in the Halifax Shipyards for Southeastern Commonwealth Drilling Limited, individually costing from $13 to $21 million. These units, the SEDCO "H", "I", and "J", are among the world's largest semi-submersible rigs, built to withstand the severe winter conditions that prevail off Canada's sea coasts.

SEDCO units are about 350 feet long, more than 380 feet wide, and have an operating weight of about 20,000 tons. The deck is almost 150 feet above the base, and the total height from the top of the drill mast to the base is 330 feet. These units can drill to a subsurface depth of 25,000 feet in some 800 feet of water. The unit normally floats, but, in water depths of less than 100 feet, it can sit on bottom. Sixty-five men can be housed on the unit, and they are transported to and from it by large passenger helicopters. On the East Coast, this entails distances of more than 200 miles from the local airport to the rig, some of the longest distances encountered anywhere in the world for personnel movement by helicopter. Supporting the drilling unit are specially designed supply vessels that bring, from a supply depot onshore, all the drilling pipe, fuel, mud, water, cement, food, etc., required. Supplies are lifted onto the deck of the unit by one of its three cranes. The largest has a 72-ton capacity, while the other two can lift up to 17½ tons each.

When the rig has to be moved from one location to another, it is towed by two or perhaps three support vessels. It is accurately positioned by electronic surveying techniques at the spot where drilling is to be carried out. The rig has nine large anchors to hold it in position; these are put out under the supervision of the barge engineer. At the same time in the control room the ballast is adjusted to ensure that the drilling rig is in an absolutely upright position; this is carried out by pumping water in or out of the 80-foot diameter footings under each of the three giant legs or caissons.

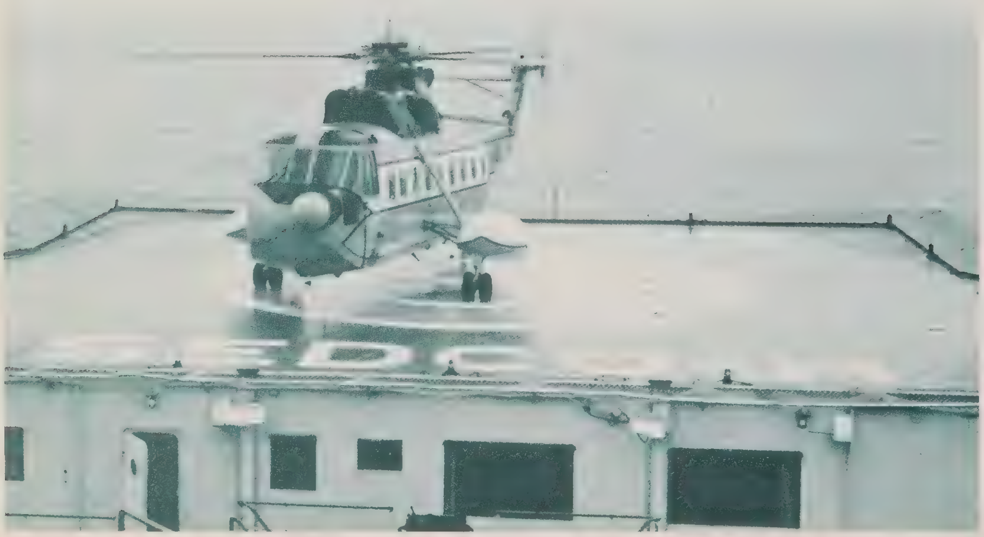
Once the barge engineer is satisfied that the rig is in a perfectly stable position, the "drilling foreman", the man responsible for the actual drilling, can start his operation. This includes, for example, setting up the blowout preventer on the sea bottom and ensuring that the mechanism is functioning properly.

A "Cadillac" of the offshore drilling units.



25,000 FT.
CAPACITY DERRICK
72-TON
CAPACITY CRANE
54-TON
CAPACITY CRANES
HELIPORT
LIVING QUARTERS
FOR 65 MEN
OVERALL
HEIGHT
325 FT.
DECK
HEIGHT
146 FT.
9 FT. DIAMETER
TUBULAR MEMBERS
CAISSON 35 FT. DIAMETER
MOORING SYSTEM
9 LINES OF 3-INCH CHAIN
EACH 2500 FT. LONG
WITH 30,000 LB. ANCHOR
PONTOON 80 FT. DIAMETER
AND 30 FT. DEEP

"Roughnecks" in action on the drill floor of SEDCO "H".



A large passenger helicopter carries the drilling crews to and from the mainland. A crew works and lives for two weeks on the unit and then has one week off.

The "riser", through which the drill pipe passes, is the vital connection between the drilling unit and the seabed.

The drilling begins and continues until total depth has been reached. An approximate final depth for the hole would have been decided upon when the initial plans were made. Daily reports on progress are sent by radio to shore, giving details such as the current depth of the hole, amount of mud used during the previous 24 hours, and the type of bit in use.

The cuttings of the rock through which the bit is drilling are pumped back to the surface in the drilling mud and then filtered out over a screen called a "shale-shaker". Samples of these cuttings are collected every ten feet of drilling depth and brought to the Canoil geologist on the rig. He dries the cuttings and, by examination under a binocular microscope, can determine the type of rock the bit is going through. He can also identify traces of oil adhering to the rock which might indicate that an oil-bearing reservoir has been penetrated by the bit. The geologist also collects bulk samples of unwashed cuttings, which are sent to his onshore office and to the RMC Branch office in Dartmouth.

At appropriate depths, operations will be carried out to obtain larger samples of rock from the well-bore. These could involve cutting a "diamond core", which is a cylinder of solid rock cut by a special tool at the bottom of the hole. This is an expensive procedure and, depending on the depth of the hole, could cost from $10,000 to $20,000. Another type of core sampling operation is the recovery of sidewall cores, which are smaller sections of rock taken from the side of the hole at various depths. All this information and material is used for various geological and engineering studies.

Federal regulations prescribe what offshore well materials must be forwarded to the RMC Branch regional office in Dartmouth, including washed, unwashed and canned cuttings, core samples, and fluid samples recovered in tests of subsurface formations, and mechanical logs. At the RMC office they are catalogued and put through various laboratory processes before being analyzed by research scientists, affiliated with the Geological Survey of Canada, who carry out their studies in a specially designed wing of the RMC regional office.

 One type of study that is carried out by the federal scientists in this building is the examination of microfossils. These are shells of minute marine animals of restricted age and habitat that are picked out from the washed samples and mounted on slides. Examined under a microscope they assist the scientists in their determination of the age of the various strata penetrated in the well and of the geological environment in which these strata were laid down. Similar studies are undertaken by oil company geologists.

All materials received from offshore exploratory wells are kept confidential for two years from the rig release date of the well. They are then placed on open file at the Dartmouth office for anyone to study. During the two-year confidential period, only the company and RMC Branch officers know in detail what information has been obtained from the well. The procedures used by the Branch in the Dartmouth office ensure that there is no breach in confidentiality that might jeopardize industry programs in the highly competitive search for oil.

Going back to our offshore well, once Canoil Company has reached the predetermined depth in the hole, further tests might be carried out and, if the well is judged to be commercially productive, steps could be taken to install recovery equipment. Prior authorization to do this must be obtained from the RMC Branch. Once this authority has been received, and the well properly completed, the drilling unit is then prepared for moving to the next location as quickly as possible. In most cases, however, the well is a dry hole, and Branch approval must be obtained for a suitable abandonment program.

If the well did indicate the presence of sufficient oil or gas to be economically viable, then the company would have to apply to convert the exploration permit to an exploitation lease. A maximum of half the permit area can be converted to lease, with the other half reverting to the Crown.

Now the company must work out details to move the oil or gas to a refinery or distribution system. Production equipment would have to be installed to recover the oil from the well, but would this be above the water or on or below the seabed? This is a difficult question to answer but will depend primarily on the depth of water and geographic location of the well.

Off Nova Scotia, platforms above the sea could be built so that a tanker could load directly from the well or wells. A more likely alternative would be a submarine pipeline to the coast. The area off the Labrador coast would present special hazards, including icebergs. This would necessitate an undersea production station, probably buried below the seafloor, that would not be damaged by passing icebergs. Whatever method is visualized, it would have to be cleared through the RMC Branch before implementation.

International jurisdiction

The increased activity in offshore oil and gas exploration has focussed attention on bilateral international problems relating to the exercise of Canadian jurisdiction over offshore mineral resources vis-a-vis that of neighbouring countries.

There are four offshore regions in which boundaries with the United States have not yet been established. These are the Gulf of Maine off the East Coast, the Strait of Juan de Fuca and Dixon Entrance off the West Coast, and the Beaufort Sea off the Arctic Coast. France claims jurisdiction over a relatively large area of the continental shelf south of Newfoundland because of her ownership of the islands of St. Pierre and Miquelon. Canada and Denmark have recently reached an agreement on respective areas of the continental shelf between Canada and Greenland.

In addition to these bilateral international problems, there is the broad international question as to how far out to sea a nation can claim jurisdiction over seabed mineral resources. Under the provisions of the 1958 Geneva Convention on the Continental Shelf, a coastal state has exclusive sovereign rights for the purpose of exploring and exploiting the natural resources of the seabed and subsoil seaward from the outer limit of its territorial sea to where the depth of water reaches 200 metres or beyond that point to where the depth of water permits exploitation.

This flexible definition of the seaward limits of national jurisdiction over seabed resources has created considerable discussion and interpretation by nations. Some countries want to minimize the effect of the "exploitable depth clause" in the Convention and thereby decrease the size of the shelf areas under national jurisdiction. Some of these nations feel that the 200-metre isobath should be considered the outer limit of national jurisdiction. Canada finds this latter concept difficult to accept, since the 200-metre isobath is an artificial limit with no real geologic-geographic significance. Much of Canada's continental shelf extends in large part well beyond the 200-metre isobath; the shelf east of Newfoundland and Labrador, for example, extends to depths of over 400 metres.

Canada's approach to this problem is that the geologic-geographic realities should be the governing factors in determining the limits of exclusive rights to offshore mineral resources. Canadian representatives at the United Nations, in particular those on the Seabed Committee, have been advancing the concept that coastal states should exercise exclusive rights over seabed mineral resources at least to the outer limits of the continental slope.

United Nations Seabed Committee

20 Canada has been active in this committee since it was established in 1967 in response to the so-called Maltese Proposal of the same year calling for the United Nations to undertake the "examination of the question of the reservation exclusively for peaceful purposes of the seabed and ocean floor and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction, and the use of their resources in the interests of mankind". Thus, attention was focussed on the crucial question—what are the "limits of present national jurisdiction" over seabed resources? This issue will culminate at the Law of the Sea Conference in 1974. Senior officials of the RMC Branch, particularly the Director, have played an influential role in this committee since its inception.

Canada has been stressing the importance of establishing an international system of resource management, including administrative machinery, for seabed resources beyond the limits of national jurisdiction. One of the stumbling blocks to agreement has been the different interpretations of the 1958 Geneva Convention in the definition of the outer limits of national jurisdiction.

In Geneva in 1971 Canada suggested a proposal to establish a form of international control for deep ocean areas. First, countries should state their maximum claims to their seaward limits of national jurisdiction, and set these claims out on maps. This would then indicate those areas of the seafloor over which no individual nation claims jurisdiction. The limits could be amended at a later date, if required, in accordance with continuing discussions. Secondly, transitional arrangements should be established to regulate activities in the indicated non-contentious areas. Canada considers this necessary to prevent the situation developing into a "free-for-all" for the minerals of the deep ocean regions. A third, and not necessarily essential element of the proposal, sets out that nations contribute to the United Nations a share of the revenues accruing from offshore mineral production within their claimed areas of national jurisdiction.

Technology is advancing so fast that exploitation of mineral resources from the depths of the oceans will likely be feasible in the relatively near future. Economics is the key factor. The rapid advance in scientific and technological knowledge is a major reason why Canada is such a strong advocate for the immediate establishment of an international body to manage seabed mineral resources in areas that do not fall under national control.

The approaches that Canada has taken on other Law of the Sea matters, such as fisheries, marine pollution, and marine scientific research, are all in close harmony with our wideshelf approach of long standing on seabed resources. They emphasize the rights and responsibilities of coastal states in line with the position we have been advocating and maintaining in the U.N. on seabed resources since the establishment of the Seabed Committee in 1967. Similar approaches put forward by a number of other states would appear to have been influenced by the Canadian wideshelf approach.

Conclusion

A vital concern of the federal government's Resource Management and Conservation Branch is the safe operation of all mineral resource activities in the Canadian Offshore. To this end, the Branch applies stringent control measures with prevention its key word.

As the steward of Canada's offshore mineral resources the Branch concerns itself with pollution-free operations, preservation of the environment, protection of human life, and conservation of subsurface resources. At the same time, the federal government's resource management policies are designed in the interests of a level of industry activity consistent with the optimum development of Canada's offshore mineral resource potential.